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FOREST RESOURCE DEVELOPMENT AGREEMENT
ENTENTE SUR LA MISE EN VALEUR DES RESSOURCES FORESTIERES

Canada Alberta

The Canada–Alberta Forest Resource Development Agreement is a subsidiary agreement of the Canada–Alberta Economic and Regional Development Agreement, which provides coordination and cooperation between the governments of Alberta and Canada in areas of Alberta's economic development.

The Canada–Alberta Forest Resource Development Agreement is funded equally by the governments of Canada and Alberta, from April 1, 1984, to March 31, 1989.

Its primary objectives are to ensure the long-term availability of timber supplies; to optimize timber uses; and to contribute to the growth and diversification of Alberta's economy.

The Agreement comprises three programs: Reforestation; Applied research, technology transfer and opportunity identification; and Public information, evaluation and administration. These programs are managed by a joint Directorate and are implemented by Forestry Canada and the Alberta Forest Service.

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L'Entente Canada–Alberta sur la mise en valeur des ressources forestières est financée à parts égales par les gouvernements du Canada et de l'Alberta, et a cours du 1er avril 1984 au 31 mars 1989.

Ses objectifs principaux sont assurer la disponibilité à long terme de réserves de bois; optimiser leur utilisation; et contribuer à la croissance et la diversification de l'économie de la province.

L'Entente comprend trois programmes: Reboisement; Recherche appliquée, transferts de connaissances techniques et relevé des occasions; et Information, évaluation et administration. Ces programmes sont gérés par un Bureau de direction conjoint, et mis en oeuvre par Forêts Canada et le Service forestier de l'Alberta.

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USING DENSITY PROFILOMETER FOR QUALITY AND CONSISTENCY MEASUREMENTS IN MDF MANUFACTURING

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DISCLAIMER

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TABLE OF CONTENTS

	PAGE
Disclaimer	(i)
Acknowledgements	(ii)
Abstract	1
Introduction	2
Quality and Consistency of Measurements	2
Density Profilometer	4
Factors Influencing Density Distribution through the Thickness of the Board	5
Future Applications	5
Profilometer Description	6
Conclusions	6
System Overview	7
System Operation	9
Option Windows	9
Set Up Window	9
Calibration Window	10
Measurement Window	10
Radiation Safety	13
System Safety	13

LIST OF FIGURES

FIG. 1 Density Profile Measuring System

FIG. 2 Density Profile for Rough Finished Sample

FIG. 3 Measuring Cycle Report

ABSTRACT

USING DENSITY PROFILOMETER FOR QUALITY
AND CONSISTENCY MEASURMENTS IN MDF MANUFACTURING.

Density is one of the key characteristics evaluated in the manufacture of medium density fiberboard (MDF). There are preferred surface and core densities depending on board application. The actual density distribution through the thickness of the board can be modified in the manufacturing process to better suit specific uses. The evaluation of consistency of average density and of the density distribution of produced boards is a very important factor of the quality analysis of MDF production.

Testing MDF using a density profilometer increases testing speed, eliminates the human error factor typical of the manual method and allows for statistical analysis of the production process. The feedback from the testing of density profiles can be used to reduce production costs and to create new products for market expansion.

Future studies based on density profile analysis are plannned to determine correlations between face and core densities versus other key MDF characteristics such as Internal Bond, Hardness, Screw Withdrawal, Modulus of Elasticity and Modulus of Rupture.

INTRODUCTION

Medium density fibreboard (MDF) is a composite panel made from combinations of pulp chips, planer shavings and/or sawdust. These raw materials are refined to a homogeneous consistency, formed into mats and then pressed into boards. The most common binder used is usually urea formaldehyde.

The boards are ready for useand are favoured in the manufacture of furniture components. The two major characteristics measured in quality analysis of MDF are:

1) Average Density
2) Average Internal Bond

Density and internal bond influence all other board characteristics. For each distinct use, a different density or internal bond may be preferred. MDF is manufacturered for different markets at densities ranging from 35 PCF to 60 PCF. Most MDF is manufactured with an average density of 48 PCF. Average density is not the only density measurement that should be considered in quality analysis. The density distribution between surface and core may differ depending on board making parameters. This density distribution influences many important aspects in furniture manufacturing:

1) Acceptance of Paint
2) Workable with Router
3) Screw Holding Capability
4) Internal Bond
5) Modulus of Rupture
6) Modulus of Elasticity

This is why it is important not only to measure the consistency of MDF production relative to average density but also density distribution through the thickness of the board.

QUALITY AND CONSISTENCY MEASUREMENTS

MDF quality is measured by its properties and the consistency in which each manufacturing facility can produce. The furniture manufacturer does not want to change his production process because of changes in the MDF that he is buying. This is why Blue Ridge Lumber (1981) Ltd. has developed an in depth Quality Control and Quality Assurance program. Both

production and technical staff are involved in the analysis of board quality and consistency. The information gathered in this program is averaged daily, hourly and yearly for each different product. This information is used as a tool for production and managerial staff to assist in the formulation of the board making process. It is used for both short and long term analyses.

Quality Control

This program consists of destructive testing of unsanded boards. Samples are randomly taken from boards exiting the press.

The measurements and tests taken are:

i) Average Density
ii) Cross Panel Average Density Variation
iii) Average Density Profile
iv) Average Internal Bond
v) Surface Porosity Ratio (Sanded Board Surface Quality Analysis)
vi) Fibre Quality
vii) Moisture Content

This information is then related immediately back to production process and monitoring equipment, eg. adjustment of on line thickness and density gauges).

Quality Assurance Testing

The Quality Assurance testing program is the analysis of finished board. It is divided into two phases, the first phase being the testing performed by the finishing and shipping production staff. Tests are done on the sander line, saw line, packaging line and as the units are being loaded for shipment. These tests include the evaluation of such things as:

i) Panel thickness
ii) Surface Quality
iii) Panel Squareness
iv) Presence of Warp
v) Visual Grading
vi) Density
vii) Packaging Quality
viii) Aesthetic Appearance

The second phase of the Quality Assurance testing program is conducted by the technical department. It includes the verification of the on line testing of the finishing/shipping staff and the random sampling of finished boards. The destructive tests performed on the finished board evaluate:

i) Average Density
ii) Cross Panel Average Density Variation
iii) Density Profiles
iv) Average Internal Bond
v) Surface Porosity Ratio and Surface Quality
vi) Fibre Quality
vii) Moisture Content
viii) Thickness Swell (24 Hour Soak Test)
ix) Screw Withdrawal
x) Linear Expansion
xi) Formaldehyde Emissions
xii) Hardness
xiii) Modulus of Rupture
xiv) Modulus of Elasticity

Quality Control and Quality Assurance tests are performed so that they comply with the MDF ANSI specifications using ASTM test methods.

DENSITY PROFILOMETER

Traditional methods of measuring the density profile of MDF are very time consuming and therefore limit the amount of data gathered for evaluation. An automated measurement of density profiles cuts down on testing time and provides enough data for statistical analysis. It also eliminates human error in density profile measurements that can be significant in some cases.

With the information provided by the profilometer on average density and density distribution between surface and core, we have the opportunity to develop specific products for specific end uses. For example high surface densities are preferred for surface painting and higher core densities are preferred for edge routering. This enables Blue Ridge Lumber (1981) Ltd. to manufacture a MDF product that attains a high degree of consumer satisfaction.

The density profiles are presented in a normalized graph and are accompanied by a process parameter information sheet. Together these allow us to verify production techniques (see Figure 2 and Figure 3).

The profilometer can be used to evaluate sand off tolerances. If a reduction of sand off is achieveable, substantial cost savings may be attained. For example a reduction of sand off on 6 mm thickness board by 0.020 inch amounts to a cost saving of approximateiy 7%. This is achieved through savings in raw material costs, resin costs, and decreased press time.

The evaluation of rough board versus sanded board can aid in the assessment of sanding techniques. The sanding operation should remove equal amounts from both sides of the board. If the sander alignment is off, sand off may vary on each side. This affects surface quality and may cause warp in extreme cases. The profilometer is used by the sander man to evaluate the quality and consistency of his work.

FACTORS INFLUENCING DENSITY DISTRIBUTION THROUGH THE THICKNESS OF THE BOARD

There are a number of process parameters that influence how a density profile looks. They are:

a) Pressing Techniques
    i) Temperature
    ii) Cook Time
    iii) Pressures
    iv) Closing Speeds

b) Resin Addition
c) Furnish Bulk Density
d) Mat Moisture
e) Total Density

A change in one or more of these parameters may change the density profile in MDF.

FUTURE APPLICATIONS

Future applications planned for the density profile data are:

A) Continued analysis of production processes to improve efficiency and maximize quality

B) Continued development of new production techniques and new products that achieve a high degreee of customer satisfaction.

C) Develop correlation of structural data of boards versus core and surface densities. eg. Modulus of Rupture vs. Face Density, Core Density vs. Screw Withdrawal, Core Density vs. Internal Bond.

CONCLUSIONS

The use of a profilometer assists with the assessment of product quality and consistency standards. This allows production process evaluation and product development or design. The profilometer eliminates the human error associated with destructive testing, it is a rapid and precise test method, and permits statistical analysis for determining trends. Financial benefits may be attained by:

A) Fine Tuning the Production
B) Improving Board Quality and Consistency
C) Development of New Products for Greater Customer Demand

Future trend analyses will include surface and core densities versus key MDF characteristics as MOR, MOE, Internal Bond, Hardness, Screw Withdrawal, and Surface Porosity product development.

The density profilometer is an excellent tool for achieving superior quality standards for MDF products.

PROFILOMETER DESCRIPTION

The RECOM 8900/DA density analyzer is an integrated system for laboratory testing of samples of boards taken from the production line. It consists of a specialized software package running on a minicomputer under a multiuser operating system. Main components of the density analyzer are: MicroVAX computer, computer operated Gamma radiation source and detection system, computer operated sample positioning system, operator's terminal with graphic monitor and a printer.

The testing is fully computerized so an operator's activity has been reduced to a supervisory role. There is no need for previous computer experience since the operator only provides samples for testing, places them in the sample magazine and selects menu driven settings. The set up is software selectable by means of an electronic mouse active in a set of windows. All calculations are performed by the computer. The results are displayed in numerical and graphic form on the operator's terminal illustrating density distributions of tested samples.

FIG. 1
Density Profile Measuring System

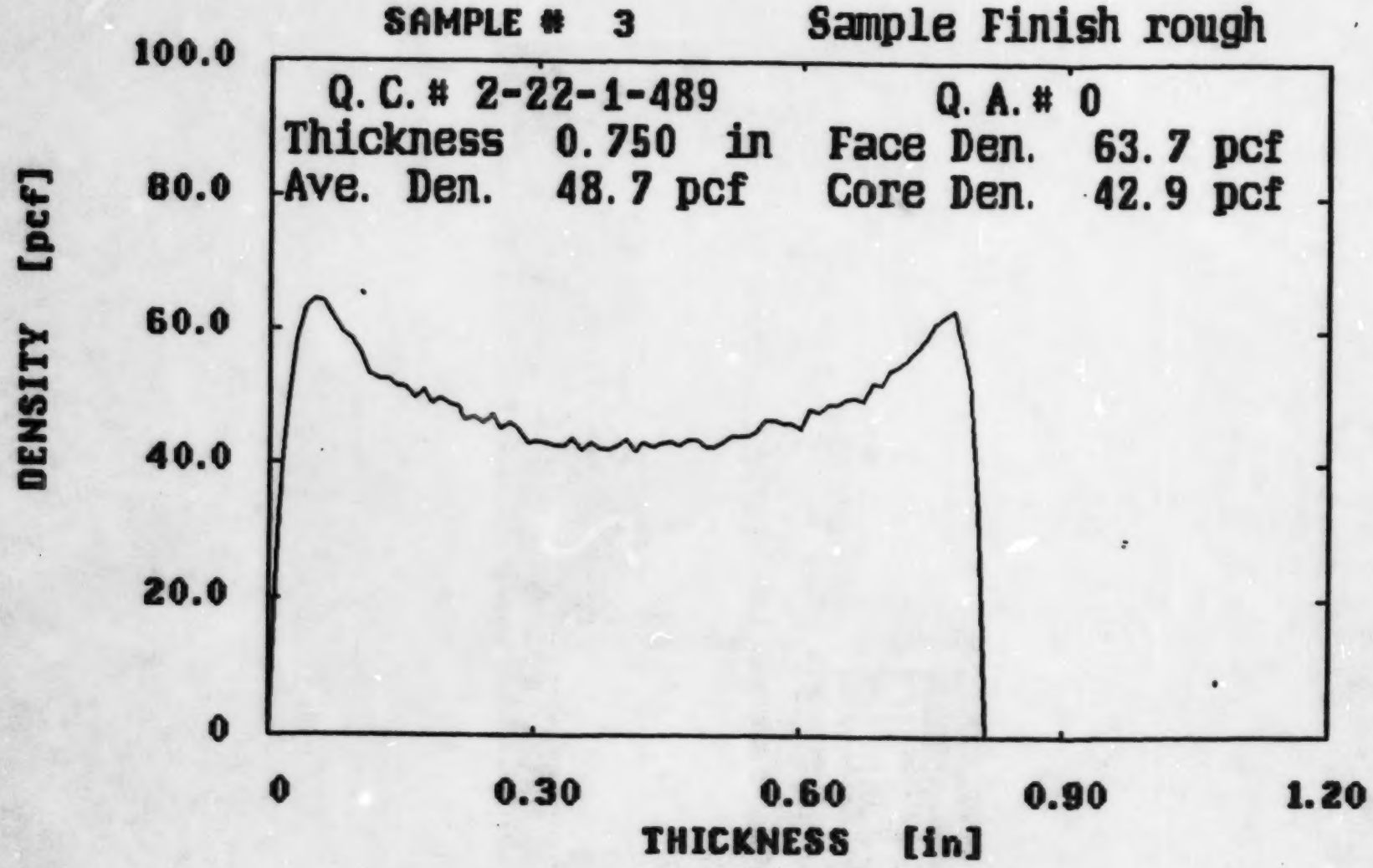

FIG. 2

Density Profile for Rough Finished Sample

BLUE RIDGE LUMBER (1981) Ltd.
RECON (1987) DENSITY PROFILOMETER
REPORT PAGE 1

Blue Ridge, 22-FEB-1989 14:04

Sample Number	8		Product Code	0
Q.C. #	2-22-1-489		Sample Finish	rough
Q.A. #	0		Sanded Thickness	0.750 in
Preseload Number	7			
Platten Number	4		Resin Content	0.0 %
			Fibre Bulk Density	0.00 pcf

Comments:

Mat Weight Actual	0		Line Moisture Content	0.0 %
Mat Weight Target	0			
No. of Operating Motors	0			
Press Time T4	0 sec.		Press Temperature	0 °F
Press Time T5	0 sec.		Press Position L1	0.000 in
Press Time T6	0 sec.		Press Position L2	0.000 in
Press Time T7	0 sec.		Press Position L3	0.000 in
			Press Position L4	0.000 in

Comments:

Core Temperature (@Max)	0 °F		Sample Weight	g
Core Temperature (@T7)	0 °F		Sample Thickness	in
Average Internal Bond	0 PSI		Approximated Density	pcf
Average Sample Density	48.7 pcf		Face Density (Top)	64.4 pcf
Average Face Density	63.7 pcf		Face Density (Bottom)	63.0 pcf
Average Core Density	42.9 pcf			

FIG. 3

Measuring Cycle Report

The RECOM 8900/DA density analyzer organizes testing of samples and provides a higher speed of test execution and documentation of the results. An operator can select resolution of measurements, i.e. step size or number of measurements per sample. He can also select either imperial or metric units. The density graph may be displayed showing chosen units or it may show relative density values normalized with respect to the average density. The computer system stores the settings so that they can be automatically reproduced at the beginning of each testing session.

SYSTEM OVERVIEW

The RECOM 8900/DA analyzer operates on a principle of penetrating radiometry. The source of radiation (Americum 241 with intensity 100 miliCuries) is located in a source box constructed to comply with all safety regulations assigned to this application.

The RECOM 8900/DA analyzer is equipped with a MicroVAX computer controlling all of the device functions and providing eight RS-232C ports for external network communication with MS-DOS operated microcomputers and/or printers and plotters.

The RECOM 8900/DA analyzer features a removable magazine allowing for testing of a multiple number of identical product samples during one test cycle. The minimum numer of samples to be placed in a magazine is five for 1.125 inch thick product. The maximum number of samples is twenty for a 0.250 inch thick product. After all samples are placed in the magazine and the magazine is inserted into the moving cage, the test cycle is initiated manually by pushing the "Start" button located on the front control panel.

Indexing of samples will now be performed by the microstepping motor assembly. During each step the analyzer will take radiation measurements that are further processed by the computer. After the measuring cycle has been completed for all samples in the magazine the motor assembly will immediately return the sample cage to the starting position. The same magazine may now be removed, unloaded and reloaded with new samples.

All testing results such as Average Density, Top Surface Density, Bottom Surface Density, Average Surface Density, Core Density are printed on a one report page together with additional information describing pressing conditions. Other complementary data such as moisture content, resin addition,

times and temperatures of the press cycle, material weights, etc. are provided by an operator while the density measurements are being taken. The second page of the report shows a graph of density distribution between top and bottom surfaces of the same board sample.

There is virtually no need to have any previous computer experience in order to test panel samples using the RECOM 8900/DA density analyzer. On the other hand, it is highly recommended that the person who is using it understands the basic features offered by the operating system. The RECOM 8900/DA density analyzer equipped with a MicroVAX computer workstation offers additional features such as text and graphics processing packages.

The current version of the RECOM 8900/DA density analyzer described in this manual has been implemented on a VAXStation 2000 minicomputer running under the VMS operating system.

The operator communicates with the density analyzer software by means of Menu Windows. All functions of the analyzer can be activated by operating an electronic mouse, a pointing device used for selecting the desired feature. There, menu windows are nested i.e. choosing one option leads to a next window with a detailed set of sub-options.

The main window where you start and end the session is called Option Menu. There are four options at this level:

* Measurement
* Set Up
* Calibration
* Exit

Device calibration is completed once for a specifc group of products that are built of similar components. In cases where the measured product differs significantly from that used for calibration, and the measured average density requires correction, the device can be recalibrated to account for chemical differences of the product.

The Set Up option allows for the selection of units to be presented on the graph, and selection of the mode for defining device resolution.

The measurement option issues a prompt for entering thickness and selecting the resolution for each tested sample and then starts the measuring procedure.

SYSTEM OPERATION

Fully automated functions of the device are activated via windows appearing on the terminal screen in the form of menus. An operator selects available options using an electronic mouse as a pointing device.

The first function of the device following start up is to return the cage with the magazine for tested samples to the reference position on the right side of the precision table. When the cage stops at the limit switch the shutter opens and the device is balanced to ensure compensation of the reference count level.

At the same time the main window, called the Options Menu, appears on the screen. From here the testing session can be started or terminated.

To select the Set Up from Options Menu, use the mouse as follows: position the arrow so that the set up line becomes highlighted and then depress the left most button of the mouse. In order to avoid accidental selection, you must confirm your choice.

OPTION WINDOWS

The Options Menu provides means to select between measurement, calibration and set up routines. All activities originate from that menu and it also provides an option to exit from the analyzer software package.

SETUP WINDOW

The Setup window provides the selection of:

* "imperial" or "metric" - the display mode for the density and sample thickness units on the graph

* "absolute" or "relative" - the display mode for the density units on the graph

* "step size" or "number of steps per sample" - the definition of measurement resolution

To make a selection in the Setup window use the mouse as follows: position the arrow at the desired option and depress the left most button of the mouse. The option currently in use will remain written in bold characters.

After all selections have been completed exit the window and return to the Options Menu.

CALIBRATION WINDOW

Calibration is performed once for each category of material. One is advised to experimentally determine the range of products that fall into the same category. Since wood fibers, resin and other chemical additives show different properties as far as the Gamma radiation absorption is concerned, some drastic changes in resin addition to the tested material may require recalibration of the analyzer.

The purpose of calibration is to insure that the calculated average density has the proper magnitude i.e. that the results are quantitatively correct. The form of the measured density profile is not affected by the calibration so at any time the density profiles are qualitatively correct. If the graphs are displayed in the relative form (1), the device does not require calibration.

(1) See "relative" option in Setup Window.

The calibration window issues a prompt for entering the number of reference samples used for calibration of the device. When the Keyboard Active Area (KB) in the upper right window corner is highlighted, enter the appropriate value. Before pressing [Return] make sure that the value entered is correct. There is still time to correct it.

To calibrate the RECOM 8900/DA analyzer you have to provide data about the actual average density of samples used as a reference. For proper calibration measure sample weights and dimensions very carefully and enter the results via appropriate windows.

MEASUREMENT WINDOW

To start the testing cycle select Measurement on the Options Menu.

The measurement window prompts for entering the number of samples tested. When the Keyboard Active Area (KB) in the upper right window corner is highlighted, enter the appropriate value. Before pressing [Return] make sure that the value entered is correct. There is still time to correct it.

Thickness Entry Window

* Select Thickness Entry Window and enter actual thicknesses of each sample:

  - point an arrow at a desired sample number,
  - depress the left most button of the mouse and check if the Keyboard Active Area (KB) in the upper right window corner is highlighted,
  - enter sample thickness and depress [Return].

* If you have to enter the same value several times:

  - read the value into the memory by depressing the central mouse button. The memory content is displayed in the highlighted area.
  - point an arrow at a desired sample,
  - read the value from memory by depressing the right most button.

Profile Resolution Entry Window

Profile resolution can be set up individually for each sample measured during one testing cycle.

Profile resolution is defined either as a number of measured profile points per sample or as a step size, i.e. a distance between adjacent points for the profile. The definition is a software selectable. For a fixed step size the number of points measured per each sample increase with the sample thickness and so does the measuring time. This option makes all points of the profile equally spaced.

For a fixed number of points per sample, the measuring time remains constant regardless of sample thickness. This option produces very detailed profiles for thin samples and less detailed profiles for thick samples since step size increase with sample thickness.

To set profile resolution for measured samples:

* Select Resolution Entry Window and enter desired value for each sample:

  - point an arrow at a desired sample number,
  - depress the left most button of the mouse and check if the Keyboard Active Area (KB) in the upper right window corner is highlighted,
  - enter resolution and depress [Return].

* If you have to enter the same value several times do the following:

- read the value into the memory by depressing the central mouse button. The memory content is displayed in the highlighted area,
- point an arrow at a desired sample,
- read the value from memory by depressing the right most button.

After entering the data for all samples used in a testing cycle, load samples into the magazine, secure the magazine in the sample cage assembly, and depress "Start" button on the front panel. Make sure that the cage travels smoothly inside the testing area, stops under the radiation detector and the shutter opens. Close the precision table safety cover and wait for the Manual Data Entry Window to appear on the screen.

Manual Data Entry Window

The manual data entry window provides a means for enhancing the density analysis report of a sample by additional information describing the production process. The details about press settings, temperatures, resin additions, resulting product IBs, etc. will accompany measured values of sample surface, core and average densities and can be used for evaluation of production methods.

The manual data entry window is displayed by a separate process running parallel to density measurements This allows you to take your time during all data entries while samples are being tested by the computer. The process measuring sample profiles will wait for you before printing final reports.

The manual data entry window is sample oriented, i.e. it allows you to edit all data entries regarding the same sample on one page.

Report Printing

The reports are printed once both the density measurements and the manual data entry process have been completed.

Testing results of each sample are documented on a two page report.

The first page contains sample identification, and all manual data entries and density testing results: for average density, surface density and core density. The second page contains sample identification, average, surface and core densities and a graph showing density profile.

A graph may show density profile in relative units, normalized with respect to average density (%), or in metric or imperial units (kg/m3 or pcf). The form of graphic representation is selected in the Setup Menu.

RADIATION SAFETY

The RECOM 8900/DA analyzer utilizes an Americium-241 (Am-241) sealed radioactive source contained in a Radiation Source Box Assembly. The device has been approved by and is registered with the Atomic Energy Control Board (AECB) Radioisotopes and Transportation Division for distribtuion to persons licensed in accordance with Part I of the Atomic Energy Control Regulations.

SYSTEM SAFETY

The shutter status lights, one green and two red, are located on the front panel of the device, and signal the state of the radioactive source shutter. When the green light is on and the two red ones are off, it signals that the shutter is in the closed position. When both red lights are on and the green light is off, it signals that the shutter is in the open position.

When the red warning lights are on, it is important that personnel keep their hands clear of the source box area.

The EMERGENCY STOP push button on the front panel is provided for a quick power disconnect to the electromagnetic radioactive source shutter mechanism. When the EMERGENCY STOP push button is returned to its normal (Enable) position, the power becomes available for the shutter mechanism and the shutter opens.

The shutter will automatically close should there be a loss of power to the system.